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3D-Vehicle Associated Research Fields for Smart City via Semantic Search Approach

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***Abstract*—**This paper presents 15-year trends for scientific studies in a scientific database considering 3D and vehicle words. Two words are selected to find their associated publications in IEEE scholar database. Both of keywords are entered individually for the years 2002, 2012, and 2016 on the database to identify the preferred subjects of researchers in same years. We have classified closer research fields after searching and listing. Three years (2002, 2012, and 2016) have been investigated to figure out progress in specified time intervals. The first one is assumed as the initial progress in between 2002-2012, and the second one is in 2012-2016 that is fast development duration. We have found very interesting and beneficial results to understand the scholars' research field preferences for a decade. This information will be highly desirable in smart city-based research purposes consisting of 3D and vehicle-related issues.

***Keywords*—**Vehicle, 3D, smart city, scholarly search, semantic.

I. Introduction

THIS work focuses on the tracking of associated fields of two keywords, 3D and vehicle. Many of the review studies include all the highlighted papers within a period of time. In contrast, we investigate specified studies in two different years whose duration in between is selected as ten years. Today's scientists intuitively believe that most of the computer vision related application fields have been widely studied for the last decade.

Many other review methods have been proposed and implemented for the same purposes. Such schemes include the studies of [1]-[9]. Our approach uses the one shot search by filtering two words on the IEEE Explore Database to find associated research fields. An example is the work of Macenko et al., which provides both a good explanation of the approach to using review and a highly relevant practical application in research areas [10].

The following sections describe the overall approach and experimental results. Conclusions are given at the end.

II. Searching by Keywords Filter

In this paper, determining most popular scientific research areas problem using keywords is tackled with selecting the scholar IEEE database search filter for 3D and vehicle based studies. This study has been realized for two-time duration. The first term is assumed as initial period and handled 10-year period during 2002-2012. The second is considered as fast progress period and handled 5-year period during 2012-2016. The results for three years (2002, 2012, 2016) can be seen in Table I.

We found thousands of studies when we tried individual keyword 3D or 'vehicle'. We have given the number of papers returned from IEEE Xplore Database for searching keywords, "*vehicle*", "*3D*" and "*vehicle and 3D*", for single years, 2002, 2012, and 2016. We have selected the returned results for keywords "vehicle" and "3D", which are totally 918, while the others have totally returned over 15000 as seen in Table I. The basic premise behind the underlying objective is that prediction of an entire picture on research areas is useful, desired, or even practical. In lieu of this reasoning, the 15-year gap is chosen to help to determine advancements in the next researches as the most likely trends of the next years.

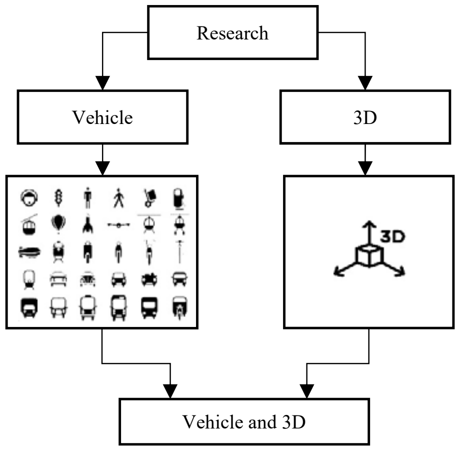

Fig. 1 Searching system type

TABLE I
Number of Papers Returned from IEEE Xplore Database for Searching Keywords (Vehicle, 3D and "Vehicle" and "3D") for the Single Years, 2002, 2012, and 2016. Date:10 APR 2017

Keywords	Vehicle	3D	"Vehicle" and "3D"
2002-Num. of papers	2909	2150	76
2012-Num of papers	10448	7272	336
2016-Num. of papers	14371	7660	509
Total	27.728	17.082	918

Research fields can be listed as

1. 3D Reconstruction, Retrieval, Modeling, Simulation, Game, Virtual Reality, Visualization, Education.
2. UAV, Autonomous vehicle, Cooperative, Path Planning, Aerial, Unmanned.
3. Network, Wireless, Communication.
4. Sensor-based, Multisensory Fusion, Information Fusion,

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Multiband, Data Acquisition.
5. Tracking, Pose Estimation, Detection, Facial, Biometry, Collision Avoidance.
6. Heuristic, Optimization, Swarm.
7. Semiconductor, Fabrication, Packaging, RFID, Nano, Embedded, Photonics.
8. Detection-Classification, Localization, Segmentation, Recognition, Scene Understanding.
9. Behavior, Situational Awareness, Real-Time.
10. Spatial, Geo-Location, Mapping, Geo-Data, Navigation, Ocean.
11. Vehicle technology, Hybrid and Electric Vehicles
12. Others

Number of papers in the research fields above for three years is given in Table II.

III. Experimental Results

Correlation between 2002 and 2012 is 0.7712, and correlation between 2012 and 2016 is 0.8091. High correlation means that researchers are conservative to generate novel scientific areas. As some of subjects are getting importance, some of them lost their popularity, but they compensate each other. Fig. 2 indicates the initial term for 2002-2012, and Fig. 3 represents the fast progress period of 2012-2016.

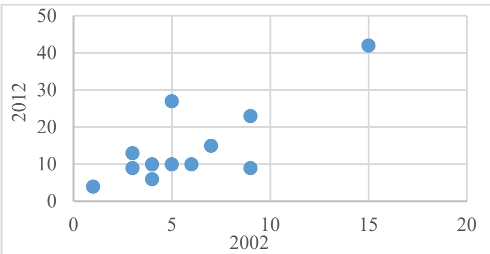

Fig. 2 2002-2012 distribution by research fields paper numbers

TABLE II
Number of Papers in Research Fields for 2002, 2012, 2016

	2002 year	2012 year	2016 year	References
1	9	40	52	[11]-[20]
2	15	69	78	[21]-[29]
3	3	27	42	[30]-[38]
4	6	28	35	[39]-[47]
5	7	27	32	[48]-[54]
6	2	7	12	[55]-[63]
7	5	35	47	[64]-[72]
8	3	32	53	[73]-[80]
9	4	17	30	[81]-[88]
10	9	16	24	[89]-[96]
11	5	23	67	[97]-[103]
12	4	15	37	[104]-[112]
std. dev	3.62	15.93	18.36	
average	6.00	28.00	42.42	

Increase of standard deviation depicts some of research fields in 2012 which have been studied 4.40 times more than 2002, and even proportion of average values is 6.6. Those in 2016 have been studied 1.15 times more than 2012, and even proportion of average values is 1.50. If we apply for T-test with 0.95 confidence, we find 0.0132 and it shows that there is a meaningful difference between two samples. Then, we can check the maximum and minimum two differences to interpret novel, developing and losing research areas.

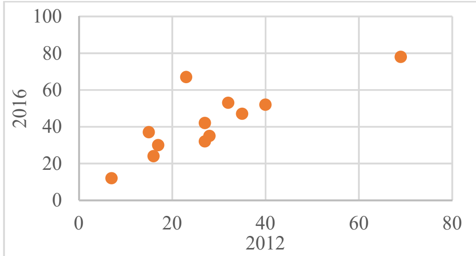

Fig. 3 2012-2016 distribution by research fields paper numbers

Max differences between 2002-2012:

69-15=54Autonomous vehicles

40-9=31 Reconstruction

Min differences between 2002-2012:

7-2=5 Heuristic

16-9=7 Spatial

Max differences between 2012-2016:

42-15=44 Vehicle technology

27-5=22 Others

Min differences between 2012-2016:

12-7=5 Heuristic

32-27=5 Tracking

Some of fields lose their popularity and some of them gain much. From Fig. 4, two peaks can be remarkable on the graphic, which are related to UAV and semiconductor manufacturing.

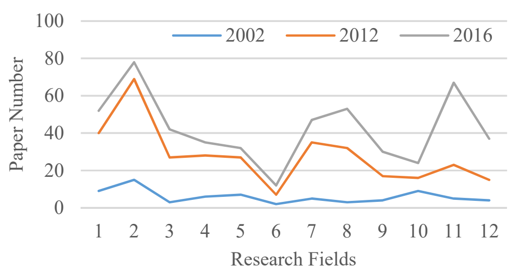

Fig. 4 2002-2012 number of papers in classified research fields

Both of them are promising area in researchers' opinions as to 2012. The areas that stand out in 2016 are UAV and Vehicle technology. Advancements in unmanned vehicle is getting increased. Because the sense in this area was only in special applications 15 years ago, but towards 2016 scientists have been studying unmanned vehicles in agriculture, self-driving, chemical, nuclear, medical, space, nano industries. It indicates that as many industries rapidly develop, quantity and quality of unmanned researches in associated with mentioned areas will increase.

There is a close relationship between unmanned and IC fabrication-nano technology research fields, because both of them are related to the advancements of the associated industries such as chemical, medical, space, vehicle. Therefore, it motivates sharply quantities and quality in both research areas. On the other hand, Heuristic, Optimization, Swarm and Spatial, Geo-location, Mapping, Geo-data, Navigation, Ocean research areas are nearly the same as far as quantities of research. Common intuitions related to them are as below;

- Associated research fields are getting develop,
- They have been widely using,
- Industrial developments motivate research studies,
- Financial supports have still been continuing,
- Sub-sectors have been developed,
- Researchers believe that these areas are more promising in the future,
- Researchers have been following state of the art studies, and their quantities,
- Mentioned sectors are commonly critical for the countries around the world.

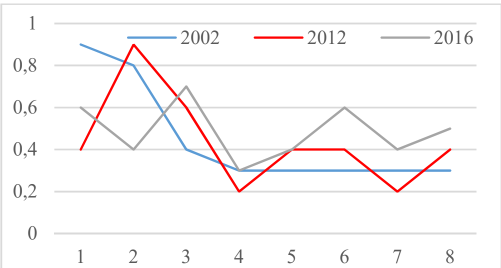

Fig. 5 Normal probability distribution of research fields

A. How to Build an Estimation Linkage in 2016 to 2012 Total Citation Numbers of Papers According to Research Fields in 2002

For computational efficiency, the estimated ROIs are searched in nine different positions for vehicles' images which match to those found in previous frames. The search strategy selected in this work is similar to the Matching Pursuit transform and the corresponding Gabor wavelets. In our case, however, the Gabor wavelet basis functions are adaptively formed in accordance with the shape and size of each vehicle being tracked.

A pair of datasets is used in experimentation from IEEE Xplore database, e.g. keywords for vehicle and 3D. Keywords provided in the databases are in AND constraint. Fig. 4 shows the results of the algorithm's tracking features. Over the course of the research progression, the approach tracks the developments and contents of the specified years in a decade. This approach sketches attempts of researchers to isolate and track relevant promising research areas.

The red lines in the figure represent the tracked path of the objects, while the numbers act as bounding box labels. Close observation of the images shows that there are two kinds of tracked bounding boxes. One type is the single blue box as seen with regards to boxes 2 and 3, and the double lines green and blue boxes. Regions such as those of 2 and 3 exist because their associated feature is no longer being tracked, at least in the current frame. This can happen for one of three reasons; the object has moved off the screen, tracking has been temporarily lost on the object, or the object is an erroneously tracked region as in the case of region 3. Region 3 was an artifact associated with region 1 that was tracked across several frames.

Quantitative measurements of tracking error have been made in the least mean square sense (LMSE) yielding an acceptably low tracking error as in [2]. Here, the main goal is to capture and track the moving objects in various road conditions.

IV. Conclusions

This paper presents a time-varying search filter result for use with vehicle and 3D.

The motivations for attitudes of researchers can be stated as:

1. Most of researchers are considering up-to-date subjects.
2. Some of the subjects are not studied such as facial works in our example.
3. Unmanned fields are getting very promising.
4. Embedded and nano-scale fabrication is one of the mostly studied fields
5. Researchers are not reluctant to novel research fields, instead they prefer yielding return areas such as unmanned vehicle technologies and semiconductor industry. It verifies that researchers follow more concrete developments in selecting topic of study.
6. Between 2002 and 2016, researchers generate more papers in different research fields. Their attitudes are proportional to state of the art studies.

Future work involves extending the one shot pair of 2 years' study in a decade to every year in one-decade scheme with feature selectivity (e.g., real time, theoretical, industry based implementations).

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